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ORIGINAL RESEARCH—HEAD AND NECK CANCER

Impact of shoulder complaints after neck dissection on shoulder disability and quality of life

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OBJECTIVE: To explore relationships between shoulder complaints after neck dissection, shoulder disability, and quality of life. To find clinical predictors for mid- to long-term shoulder disability.

STUDY DESIGN: Prospective.

PATIENTS AND METHODS: Shoulder pain, shoulder mobility, and shoulder droop, as well as scores on shoulder disability questionnaire and RAND-36 (quality of life), were measured at baseline, discharge (T1), and 4 months postoperatively (T2) on 139 patients admitted for neck dissection to major head and neck centers in the Netherlands.

RESULTS: Shoulder mobility was significantly decreased at T1 and did not improve. Significant relationships between shoulder function, shoulder disability score, and RAND-36 domains were found. Two clusters of clinical symptoms could be identified as independent predictors for shoulder disability.

CONCLUSIONS: Objective deterioration in shoulder function after neck dissection is associated with perceived shoulder disability and related to physical functioning and bodily pain. Predictors for shoulder disability can be found.

Shoulder complaints after radical neck dissection have been described by Ewing[1] as early as 1952 as "the shoulder syndrome," consisting of shoulder pain, restricted range of motion, shoulder droop, scapular winging, and abnormal electromyographical findings. Reported prevalences of shoulder complaints range from 47 to 100 percent after radical neck dissection, 18 to 61 percent after modified dissections, and 29 to 52 percent after selective dissections.[2-4] Risk factors for shoulder pain and restricted range of motion are sacrifice of the accessory nerve and plastic reconstructions with myocutaneous flaps.[5] Several explanations have been proposed to account for shoulder pain and loss of range of motion, including adhesive capsulitis, paralysis of the m. trapezius pars descendens, myofacial trigger points, acromioclavicular (AC) or sternoclavicular (SC) luxations, and neuropathic disorders.[3,6-8] Few prospective studies assessing shoulder complaints after neck dissection have been performed.[5,9,10]

In a recent prospective clinical study, incident cases of shoulder pain were identified, and risk factors for shoulder pain after neck dissection were determined.[5] A limitation of that study was that follow-up ended at the day of dismissal from the hospital, leaving unclear how shoulder complaints after neck dissection develop over time. Perceived shoulder disability was measured in a prospective study. Patients after neck dissection all reported worse shoulder function after 6 and 12 months.[11] However, in this study, no objective findings from a physical examination were used, nor were interactions between shoulder disability and other domains of quality of life studied. It seems likely that shoulder complaints will influence health-related quality of life (HRQOL).

Exercise programs seem to have positive effects on shoulder complaints and shoulder disability.[12,13] These programs consist of intensive exercise therapy. However, patients have to cope with other problems besides shoulder complaints in the first months after neck dissection, such as the burden of adjuvant therapy or psychosocial problems. It could be argued that the first months after surgery are not the most suitable time to start intensive exercise therapy. It would therefore be useful to identify clinical risk factors for mid- to long-term shoulder disability so that benefits can be balanced against costs for individual patients. The primary aim of our study was to explore the development of shoulder function disorders in the postclinical phase and their relationship to perceived shoulder disability and HRQOL. The secondary aim was to find clinical predictors for mid- to long-term shoulder disability in activities of daily living, in terms of objective findings from physical examination and patient characteristics.

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METHODS

Patients

Four Dutch head and neck centers participated in this multicenter study; The Netherlands Cancer Institute – Antoni van Leeuwenhoek Hospital (NKI-AVL), Leeuwarden Medical Centre, University Medical Center Groningen, and VU University Medical Center. Between 2003 and 2005, a sample of 139 patients was included in our study. Inclusion criteria were age ≥18 years and admission for neck dissection. Patients who had shoulder pain on the side of the neck dissection in the week before surgery were excluded. Patients were also excluded if they lacked basic proficiency in Dutch or when they had serious cognitive or psychiatric disorders.

Variables Measured and Treatment of Patients

Because shoulder function and quality of life assessment are part of routine health care evaluation in the participating hospitals, obtaining approval from a medical ethics committee was not necessary. However, verbal informed consent regarding the use of these measurements for the purposes of this study was obtained and documented in the case record form for all patients. All data were anonymized for confidentiality. Approval of publication of the study results was granted retrospectively by the NKI-AVL Medical Ethics Committee. Sociodemographic data and information on tumor type, localization, staging, type and extent of surgery, type of reconstructive surgery, side, type and extent of neck dissection (radical, modified, or selective neck dissection, structures preserved),[14] radiotherapy, and use of pain medication were derived from medical records. The day before surgery (T0), patients completed the shoulder disability questionnaire (SDQ) and the RAND36, a questionnaire that assesses health-related quality of life. The SDQ is a validated 16-item questionnaire that describes a variety of situations during which the patient might experience shoulder problems (pain or restricted range of motion). The calculated score ranges from 0, indicating no disability, to 100 points, indicating total disability.[15]

The RAND36 is a validated 36-item questionnaire and is very similar to the SF-36.[16] Active range of motion (AROM) was assessed for shoulder forward flexion (FF) and abduction (ABD), and for cervical rotation and extension. These values were obtained with the use of an inclinometer (Mediclino, Bodybow, Nieuwegein, The Netherlands) according to a standardized measurement protocol.[17] Presence or absence of shoulder droop was recorded. Postoperative physiotherapy started immediately after removal of the wound drain and was applied according to guidelines that were developed previously and comprise mild passive and active exercises to improve and maintain shoulder mobility and muscle function, active exercises to regain mobility of the neck, and patient education.[17]

At discharge from the hospital (T1), shoulder function and shoulder droop were evaluated again. Current shoulder pain was measured with a numeric rating scale (NRS) from 0 to 10, with 0 indicating no pain at all and 10 indicating the worst imaginable pain. The shoulder joint was tested for pain during external rotation. Physiotherapy was continued in primary care setting if winging of the scapula was present during active movements of the shoulder, if pain scores were ≥4 on the NRS, if the extent of loss of AROM was extent greater than would be expected on the basis of the surgery, or if there were other reasons to expect an increased risk for developing serious shoulder complaints. The physiotherapists to whom the patients were referred were informed in writing about the type of surgery and the preferred therapy. Other patients were given home exercises or were seen regularly, but with a low frequency, on an outpatient basis. After approximately 4 months (T2), during a regular control visit to their treating physician in the hospital, patients filled out the RAND36 and SDQ. In addition, the physical examination of shoulder and neck was repeated.

Statistical Analysis

Descriptive statistics were calculated for relevant demographic and clinical variables, including scores calculated from quality of life and SDQ. For variables that were normally distributed, mean and standard deviation are presented. For variables that were not normally distributed, median and interquartile range (IQR) are presented, and 95 percent confidence intervals (95% CIs) were calculated by bootstrap resampling using 5000 iterations. Missing data from predictor values were imputed by using multiple imputation (AregImpute from Hmisc S-plus library). A binary logistic regression model was constructed to determine if the SDQ observations missing at T2 were related to any of the predictor variables. An ordinary least squares regression model was constructed to examine the relationships between SDQ at T2 and the predictor variables. In both models, the estimates and variance-covariance matrix were adjusted to account for the imputation of the missing predictor values. In the linear model, a square-root transformation of the SDQ values was employed. Because of high correlation, predictor variables were clustered by using the square of Spearman rho (Varclus from Hmisc S-plus library). A threshold of 0.5 was set to determine the clusters, and the joint influence per cluster was examined. For all tests, a two-sided $P \leq 0.05$ was considered statistically significant. All statistical analyses were performed with S-Plus 6.2 for Windows (Insightful Corporation, Seattle).

RESULTS

Descriptive Statistics

Of 139 enrolled patients, 118 (85%) completed the study. One patient died during follow-up, three had a recurrence, one patient refused further participation, one patient suffered a stroke, three patients did not return their questionnaires, and 12 patients were lost to follow-up for unknown reasons.

Table 1
Descriptive statistics of population under study and characteristics of therapy performed

Variable	% (n)
Gender	
Male	62 (73)
Female	38 (45)
Age, mean (SD)	58 (12.6)
Preoperative radiotherapy to the neck	
Yes	12 (14)
Chemoradiation	2 (3)
No	86 (101)
Side of dissection	
Left	42 (49)
Right	39 (46)
Both sides	19 (23)
Type of dissection	
Radical	13 (15)
Modified radical*	44 (52)
Selective	43 (51)
Preservation of cervical branches	
Yes	25 (29)
No	23 (27)
Unknown	53 (62)
Reconstructive surgery	
No reconstruction	64 (76)
Pectoralis major myocutaneous flap	16 (19)
Radial forearm flap	7 (8)
Fibula	3 (3)
Other reconstruction	10 (12)
Postoperative radiotherapy (n = 87)	68 (59)

*In three cases, the accessory nerve was sacrificed despite modified dissection.

Median length of follow-up was 16 weeks (IQR 14;19). Descriptive statistics of the population under study, preoperative radiotherapy, type and extent of operation and reconstructive surgery, and type and stage of tumour are summarized in Tables 1 and 2.

Information about shoulder pain at dismissal from the hospital was available for 110 patients. At T1, 55 percent of patients experienced shoulder pain. Between T1 and T2, 66.3 percent of patients had no change in pain, 14.6 percent exhibited an increase in pain, and 19.0 percent had a reduction in pain. At T2, shoulder pain was present in 48 percent of cases (Table 3). In total, 31 patients in the current study had a baseline score on the shoulder disability questionnaire (SDQ) above zero, although we excluded patients who reported they had shoulder complaints in the week before surgery and who had an NRS score for shoulder pain at T0 of ≥ 1. AROM for ABD and FF showed a significant decrease at T1, compared with T0, and did not improve substantially over time (Table 3). The changes in AROM for ABD were larger than the changes for FF. When comparing AROM of the shoulder between comprehensive (R(M)ND) and selective neck dissection (SND), both ADB and FF were similar at baseline, but significant differences existed at T1 and T2, in favor of SND (Fig 1, Table 3). No statistically significant differences in cervical mobility were found when patients who underwent SND and R(M)ND (Fig 2, Table 3) were compared.

According to the results of the SDQ, shoulder disability at T2 increased significantly, a median increase of 18.7 points, from baseline (IQR 0;50). Shoulder droop was present in 57 percent of cases and remained essentially unchanged over the follow-up period. The percentage of patients who experienced pain while resting, lying on the shoulder, during movements of the shoulder, and when walking with an unsupported arm increased between T1 and T2 (Table 3). Information on quality of life was not available for all subjects at all time points. The number of subjects described and summary data for all domains are presented in Figure 3.

Missing Data Analysis

The logistic regression model indicated that no predictors significantly related to SDQ scores were missing at T2. This indication was as expected given that the primary reasons for missing T2 scores were unrelated to the condition of their shoulder.

Correlations

Correlations between SDQ summary score and shoulder pain, ABD, shoulder droop, and RAND-36 domains are listed in Table 4. Correlations with the SDQ were significant for shoulder pain, ABD, and shoulder droop as well as for physical functioning, role limitations due to physical or emotional problems, general mental health, vitality, and bodily pain.

Multivariate Analysis

After correction for time since surgery or last radiotherapy, at dismissal from the hospital (T1) the following variables significantly predicted SDQ scores at T2:

1. (Clustered variable) AROM of ABD and FF at T1 (with smaller AROM predicting higher SDQ scores), nonselective neck dissection and the presence of shoulder droop (both predicting higher SDQ scores) (joint influence $P = 0.007$).

Table 2
TN classification on the basis of pathology report*

	N0	N1	N2	N3	Total
Tx	4	3	1	0	8
T1	13	2	5	1	21
T2	23	6	8	1	38
T3	7	3	7	0	17
T4	7	2	7	0	16
Total	54	16	28	2	100*

*TNM classification is not used for melanomas; 17 of the 118 patients had melanoma. In addition, data were missing for one patient.

Table 3
Changes (compared for each patient) of shoulder pain, and shoulder and neck function after neck dissection at T1 and T2 compared with T0

	Change T0-T1	95% CI of change (T0-T1)	Change T0-T2	95% CI of change (T0-T2)
SDQ score (IQR)	NA	NA	18.7 (0;50)	(6;31)
Shoulder pain present (% of cases)	55	47;62	48	40;56
Median NRS for subgroup with shoulder pain (IQR)	3(1;4)	2;3	3 (2;5)	3;4
Pain experienced (% of cases for subgroup with pain)				
While resting	29	19;39	37	26;48
Lying on the shoulder	45	35;55	54	41;65
During movement of the shoulder	42	32;53	46	33;57
When walking with unsupported arm	29	19;40	46	33;59
Shoulder droop (% of cases)	57	48;66	52	42;61
AROM decrease in shoulder (compared with baseline)	Median (IQR)		Median (IQR)	
Abduction	34° (1;102)	22;66	50° (0;103)	20;70
Forward flexion	19° (4;34)	14;23	20° (0;40)	10;24
AROM decrease in neck (compared with baseline)	Mean (SD)		Mean (SD)	
Rotation away from operated side	17° (15)	13;19	8° (16)	5;11
Extension	20° (18)	17;23	15° (16)	12;17
AROM differences between SND and R(M)ND	T1 difference of the median	95% CI of difference	T2 Difference of the median	95% CI of difference
Abduction	93°	64;104	90°	60;110
Forward flexion	18°	1;29	20°	9;37
Rotation of the neck away from operated side	7°	0;12	8°	0;17

SDQ, shoulder disability questionnaire; *NRS,* numeric rating scale [score for pain]; *AROM,* active range of motion; *SND,* selective neck dissection; *R(M)ND,* radical (modified) neck dissection.

2. (Clustered variable) pain on external rotation of the shoulder (predicting higher SDQ score) and NRS score (with higher NRS scores predicting higher SDQ score) (joint influence $P = 0.03$).
3. SDQ baseline (T0) score ($P = 0.04$).

The remaining variables, gender, age, radiotherapy, and recruitment center were not related to SDQ at T2. The model R-squared was 0.50; the adjusted R-squared was 0.40.

DISCUSSION

Shoulder pain was present in 55 percent of our patients on the day of discharge from the hospital. At follow-up (T2), 48 percent reported pain. Intensity of shoulder pain was not significantly correlated with the time passed since the operation, which is consistent with findings of van Wilgen et al[4] and Chepeha et al.[18]

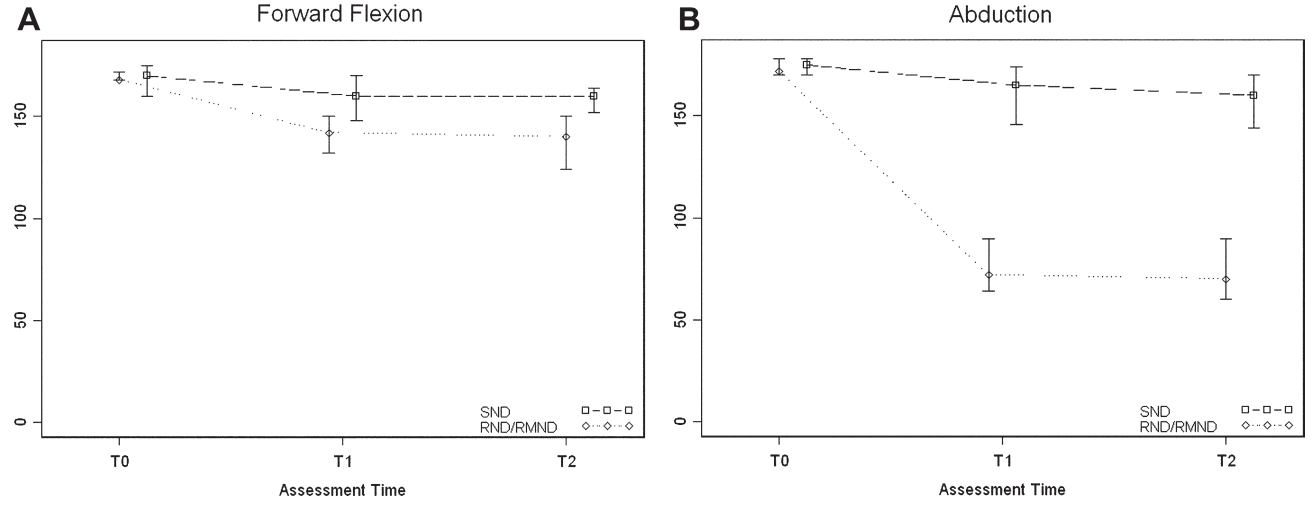

Figure 1 **(A)** AROM (°) of shoulder forward flexion before (T0) and after neck dissection at discharge (T1), and at follow-up (T2) (median and 95% CI). **(B)** AROM (°) of shoulder abduction before (T0) and after neck dissection at discharge (T1), and at follow-up (T2) (median and 95% CI).

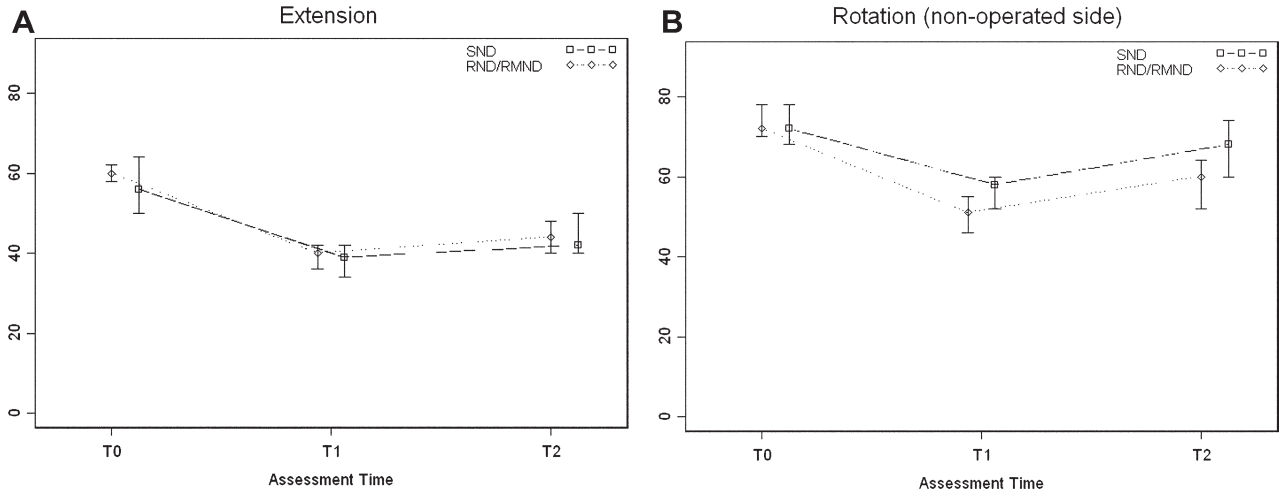

Figure 2 **(A)** Cervical AROM (°) of rotation to non-operated side before (T0) and after neck dissection at discharge (T1), and at follow-up (T2) (median and 95% CI). **(B)** Cervical AROM (°) of extension before (T0) and after neck dissection at discharge (T1), and at follow-up (T2) (median and 95% CI).

However, the NRS scores were somewhat higher at T2 than that at T1, which may be due to an increased activity level of the patients after discharge. It is noteworthy that the number of patients who experienced pain when walking with an unsupported arm at T2 is considerably larger than the number at T1. After surgery, patients are encouraged to support their arm while walking to avoid overload of muscles and joints of the shoulder girdle due to shoulder droop. Possibly, patients cease to support their arm in the months after leaving the hospital. Although pain was relatively mild, it appeared to be one of the factors related to shoulder disability. Range of motion of the neck improved over time but did not reach baseline values within the study period. However, the decrease in cervical range of motion for rotation at T2, compared with baseline, is small; although the value is statistically significant, to the best of our knowledge, it is not clinically relevant.

AROM for ABD did not improve over the period of follow-up, in either those who underwent R(M)ND or those who underwent SND. Loss of function of the m. trapezius descendens, resulting in a decreased AROM for ABD, is usually attributed to neuropraxia or neurolysis of the accessory nerve as a result of the neck dissection. Indeed, van Wilgen et al showed that a decrease in AROM for ABD of $\geq 40°$ is a useful indicator for loss of function of the accessory nerve.[19] AROM for ABD was limited to a greater extent than AROM of FF, which can be explained by the fact that, in ABD, the trapezius descendens muscle is the only muscle capable of rotating the scapula laterally, whereas during FF the serratus anterior muscle can assist in rotating the scapula laterally and the major pectoral muscle can assist in the elevation of the arm. Post hoc stratified analysis showed that, at T2, 53 percent of the patients with nerve-sparing neck dissections (R(M)ND with sparing of the accessory nerve or SND) still had a decrease in AROM of ABD of $\geq 40°$. Apparently, the duration of follow-up was too short for the nerve to recover in a substantial number of the patients. Laverick et al[20] found that shoulder disability improved from 6 months onward. It could be argued that, if shoulder disability occurs during the period in which recovery of the accessory nerve can not yet be expected, it would be useful to initiate rehabilitation that aims to attenuate or prevent shoulder disability, regardless of the prognosis of trapezius dysfunction in the time thereafter.

It was decided not to exclude the 31 patients with a baseline score on the SDQ above zero, considering that they were still at risk for increasing loss of function and development of shoulder pain. As a consequence, linear regression analyses were corrected for the SDQ baseline scores. Also, the regression analysis was corrected for time since surgery or last radiotherapy to account for the variability of these time intervals between subjects. In total 40 percent of the variance in shoulder disability at T2 could be explained by two clusters of predictors and the SDQ baseline score. Interestingly, these clusters correspond to two clinically identifiable subgroups of patients: those with shoulder complaints arising from the inability to stabilize the scapula adequately during movements of the arm, resulting in a decreased active range of motion (cluster 1), and those in whom shoulder complaints are predominantly related to glenohumeral joint disorders that were present at T1 (cluster 2). Although glenohumeral joint disorders have been described after neck dissection,[7] this outcome is probably not a direct consequence of the surgery but rather secondary to changes in postoperative use of the arm.

All of the symptoms in the two clusters (limited range of motion of ABD and FF, shoulder droop, and shoulder pain) are part of the shoulder syndrome as defined by Ewing.[1] To our knowledge, it has not been previously shown that the occurrence of this syndrome in the clinical postoperative setting is an actual predictor of shoulder disability 4 months later. Radiotherapy did not emerge as an important predictor for shoulder disability in our study. This result is in agreement with the results of van Wilgen et al.[19] On the other

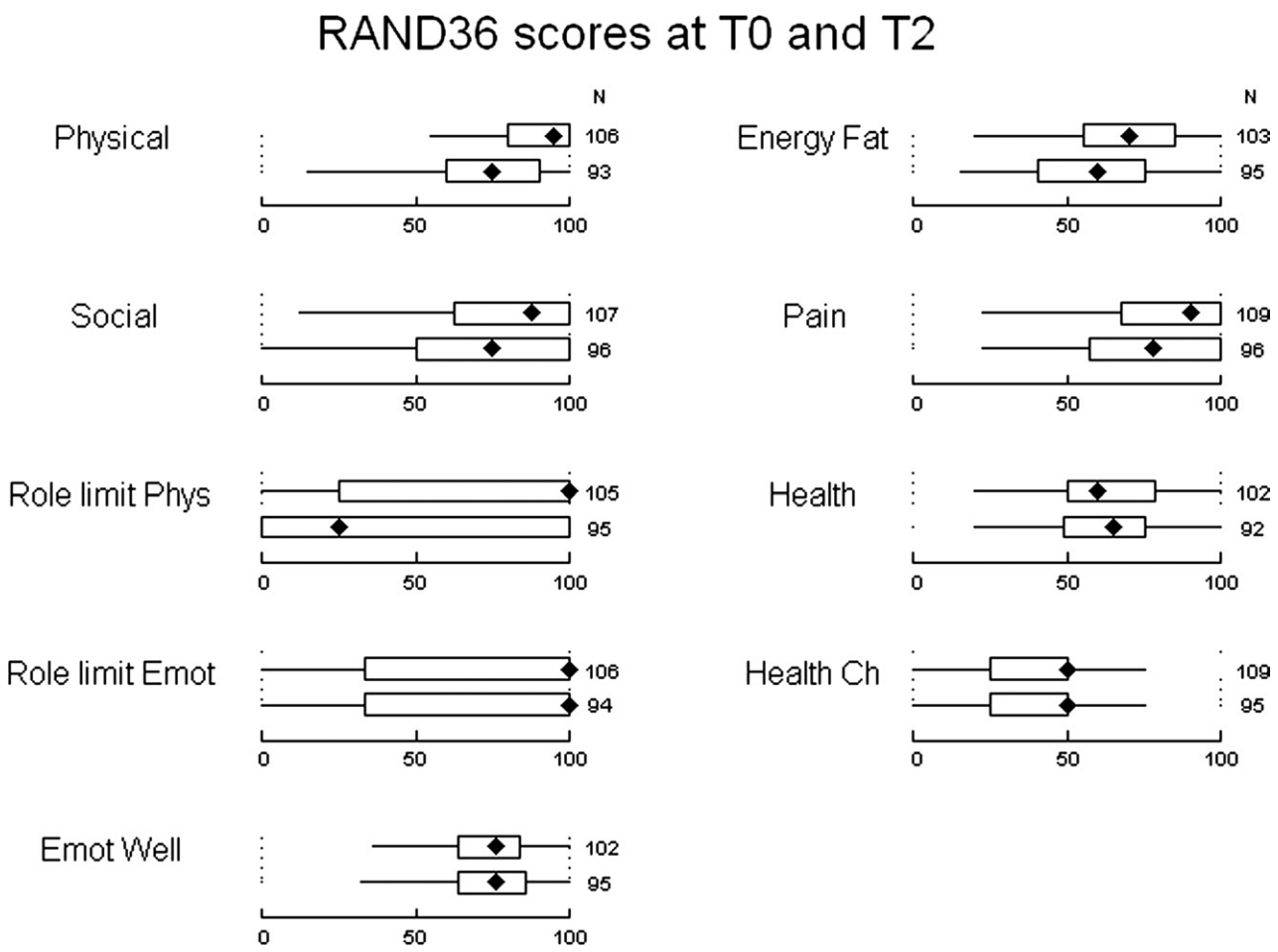

Figure 3 Box plots showing scores for the RAND 36 domains: physical functioning (Physical), social functioning (Social), role limitations due to physical problems (Role limit Phys), role limitations due to emotional problems (Role limit emot), Emotional well-being (Emot Well), Energy/Fatigue (Energy Fat), bodily pain (Pain), general health perception (Health), and health change (Health Ch), at T0 (*top*) and T2 (*bottom*).

hand, Taylor et al[18] and Chepeha et al[21] claimed that radiotherapy was an important predictor for shoulder disability, although radiotherapy was not a statistically significant predictor in the latter study. Objective findings of physical dysfunction correlated well with perceived shoulder disability as measured by the SDQ, indicating that shoulder dysfunction results in performance problems in activities of daily living. Perceived shoulder disability was in turn correlated to some domains of HRQOL, as measured by the RAND 36. Bodily pain and physical functioning were the domains with the highest correlation. Although statistically significant, these relationships are not very strong (-0.53 and -0.37, respectively). Shoulder function is just one of many factors that influence HRQOL in head and neck cancer patients; therefore, it is not very surprising that changes in shoulder function are not reflected dramatically in the scores of a generic quality of life instrument like the RAND36.[22] Physical functioning and bodily pain appeared to be the strongest affected domains after neck dissection.

A limitation of this study was the amount of missing data. Data at T1 were not available for some patients because they were discharged during the weekend or without the physical therapist being informed. However, the impact of the missing data on the results was small, because these data were not significantly related to the variable of interest (shoulder disability), and we were able to impute these data. In addition, 12 patients were lost to follow-up for unknown reasons. If patients dropped out because of reasons related to their health, this may have biased the RAND36 scores. The strength of this study was its prospective design, allowing us to investigate only those shoulder complaints that actually arose after the neck dissection, and the combination of both objective and subjective findings regarding shoulder function. The results of this study suggest that current management is not sufficient to prevent shoulder disability for a substantial part of patients after neck dissection. However, the study was not designed to evaluate the efficacy of physiotherapy after neck dissection; consequently, no "control group" is available. It is therefore difficult to judge whether the observed shoulder disability rates occur despite physiotherapy or as a result of insufficient physiotherapy. It is hypothesized that more intensive physiotherapy may be required for those patients who demonstrate all symptoms of the shoulder syndrome at dismissal from the hospital,

Table 4
Correlations (Spearman) between the SDQ score at T2 and shoulder complaints and RAND36 domains

Correlate	SDQ (T2)	95% confidence interval
NRS score at T2	0.70	0.53; 0.79
AROM abduction at T2	−0.61	−0.43;−0.75
Shoulder droop at T2	−0.65	−0.41;−0.80
RAND36 domains		
Physical functioning	−0.37	−0.14;−0.55
Social functioning	−0.11	0.12;−0.29
Role limitations due to physical problems	−0.29	−0.07;−0.48
Role limitations due to emotional problems	−0.31	−0.11;−0.49
General mental health	−0.23	−0.02;−0.42
Vitality	−0.29	−0.09;−0.47
Bodily pain	−0.53	−0.34;−0.68
General health perception	−0.18	−0.39; 0.03
Health changes	−0.23	−0.43; 0.01

whereas for patients who manifest only some of these symptoms a regimen of home-based exercises and patient education may suffice to prevent shoulder disability. However, experimental studies are required to support or reject this hypothesis.

CONCLUSION

Neck dissection due to head and neck cancer has significant negative impact on shoulder function. Deterioration in shoulder function has a negative influence on activities of daily living. Shoulder disability in turn decreases HRQOL. Clinical predictors for mid- to long-term shoulder disability are (1) a decrease in AROM of ABD and FF in combination with nonselective neck dissection and the presence of shoulder droop, and (2) a combination of pain on external rotation of the shoulder and a higher NRS score for pain.

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Martijn M. Stuiver, study design, data collection, data analysis, writer; **Cornelis P. van Wilgen,** study design, data collection, manuscript revision; **Cees J. T. de Goede,** study design, data collection; **Muriel Koolstra,** study design, data collection, manuscript revision; **Anita van Opzeeland:** study design, data collection; **Piet Venema,** study design, data collection; **Margriet W. Sterken,** data collection; **Andrew Vincent,** data analysis, manuscript revision; **Pieter U. Dijkstra,** study design, data analysis, manuscript revision.

FINANCIAL DISCLOSURE

None.

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